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NCCA SOFTWARE MAINTENANCE PROCESS SIMULATOR (SMPS)

Volume III

SMPS User Guide

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Final

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The NCCA Software Maintenance Process Simulator, or SMPS, employs a System Dynamics (SD) approach to modeling software maintenance. The SD approach enables the modeling of an evolutionary process by focusing on the interrelationships among system elements that describe a particular system's behavior. SMPS consists of simulation software, which is a combination of Excel and Powersim, and related documentation. The documentation consists of this user guide along with two other documents: *Volume I: Data Dictionary & Supplementary Analyses* and *Volume II: Framework of SMPS System Dynamics Tool*. The historical dataset data dictionary contains detailed information on the derivation of historical parameters that may be used in the simulation model as analogies. The framework manual contains detailed information on inputs, output, and algorithms that make up the SMPS simulation model. This document, the SMPS User Manual, is a step-by-step set-up and user guide to working with the input and output interfaces of SMPS.

1 GETTING STARTED

Files and Requirements

SMPS is a Microsoft Excel 2000 workbook file that runs a simulation algorithm via a dynamic date exchange (DDE) link with Powersim 2.51.[1] To run SMPS, double click on the SMPS-V1.XLS file icon in Windows Explorer. SMPS is not a stand-alone executable file. To run this file, users must have Microsoft Excel 2000 or later installed. To execute a simulation, users must have Powersim 2.51 or later, or Powersim Runtime 2.51 installed on their computers.

[1] Powersim is a registered trademark of Powersim, Inc. Microsoft and Microsoft Excel 2000 are registered trademarks of Microsoft, Inc.

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Overview

As shown below in Figure 1, inputs to the simulation model are entered through an Excel interface, and output from the simulation is stored and summarized in the same Excel file. While it is possible to work with the Excel file without having Powersim installed, actual simulation runs require either Powersim or the Powersim run-time executable files.

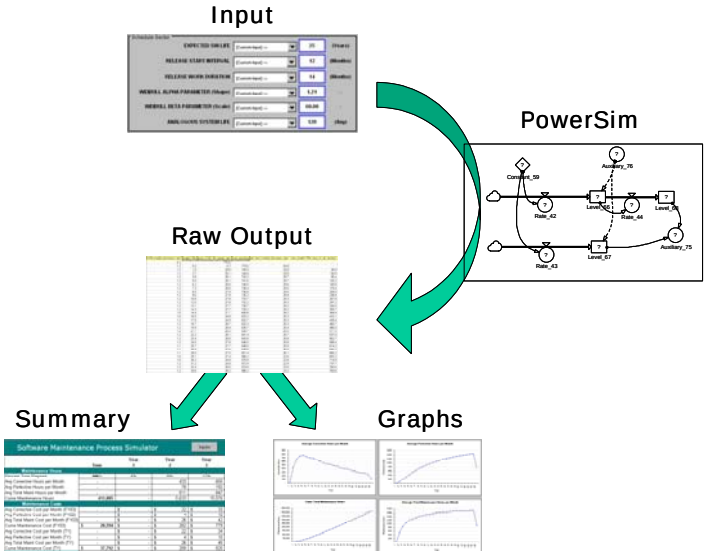

Figure 1. Data entry overview.

Inputs for the required parameters of the simulation may be historical parameters from analogous systems stored in the SMPS database, custom inputs from the user, or a combination of both. Once Powersim has executed the simulation, Powersim sends raw output to the SMPS Excel workbook. Output is then summarized, formatted, and graphed by Excel.

2 RUNNING A NEW SIMULATION, STEP-BY-STEP

This section provides step-by-step instructions for running a new simulation in SMPS. Once SMPS is initialized with the correct file paths, a simulation is executed by selecting or entering the appropriate input parameters, and then clicking "Run."

1) Open the SMPS Excel file.

To start the simulation, double-click the SMPS-V1.XLS file icon:

. SMPS will open and you will be presented with the following four worksheets.

User Inputs

The input interface to the software maintenance process

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Use the following shortcut keys to quickly access sheets.
User Inputs*: Ctrl+shift+i*
Output*: Ctrl+shift+u*
Graphs*: Ctrl+shift+g.*

simulation. On this sheet the user can select historical simulation parameters from analogous software systems or enter custom inputs for parameters.

Output

Contains summarized and formatted output for each category of simulation information. Output is categorized into maintenance hours (corrective, perfective, and total), maintenance costs (constant year and then-year corrective, perfective, and total), TRs (arrivals, closures, backlogs), ECPs (arrivals, closures, backlogs), and source lines of code (SLOC) (added and deleted).

Output Graphs

Graphically displays selected elements of information from the Output sheet.

Database

Stores simulation parameters for ten historical software systems. These data may be selected via the User Inputs sheet for use in the software maintenance process simulation.

2) Set up the simulation file paths.

If this is the first time SMPS is being run on a computer, you must tell the program where to find the Powersim executable file and the Powersim simulation program file. The executable file is the actual Powersim application that runs the simulation; the simulation program file is the program that the application executes. The program file that SMPS uses to execute software maintenance process simulations is named SMPS-V1.SIM:

.

To set up the paths to the files:

- Select the User Inputs sheet.
- Click on Paths and you will be presented with the SMPS File Paths dialog, shown in Figure 2.

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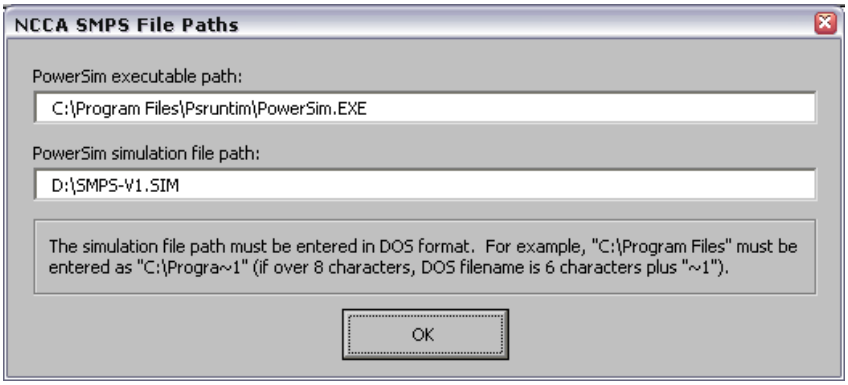
NCCA SMPS File Paths
PowerSim executable path:
C:\Program Files\Psruntim\PowerSim.EXE
PowerSim simulation file path:
D:\SMPS-V1.SIM
The simulation file path must be entered in DOS format. For example, "C:\Program Files" must be entered as "C:\Progra~1" (if over 8 characters, DOS filename is 6 characters plus "~1").
OK

Figure 2. SMPS File Paths dialog.

To verify the DOS form of the path, use Powersim's Open File menu option to browse to the location.

- Enter the path to the Powersim executable file in the top text box. The path shown in Figure 2, "C:\Program Files\ Psruntim\ Powersim.EXE," is the default directory for the Powersim Runtime version. In the second text box enter the path to the software maintenance simulation file `SMPS-V1.SIM`. The path shown in Figure 2, "D:\SMPS-V1.SIM," is the path to the file's location on the SMPS disc (where D is the CD drive letter). SMPS may be run directly from the SMPS disc. Click `OK` after entering the file paths to update the path information.

Powersim 2.51 requires all paths to be in DOS format, so be sure that the path to the Powersim simulation file follows DOS convention. No spaces are allowed for folder or file names, and any names longer than eight characters must be truncated by a tilde and a "1" character. For instance, "C:\Sim Files" must be entered as "C:\SimFil~1" without the quotes.

3) Input parameters for the simulation.

The sheet `User Inputs` contains input cells for 24 parameters required to execute the simulation. These inputs are grouped into five categories called *sectors*. Table 1 lists each sector and its associated input parameters.

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Sector	Input Parameter
Schedule	Expected SW Life
	Release Start Interval
	Release Work Duration
	Weibull Alpha Parameter (Shape)
	Weibull Beta Parameter (Scale)
	Analogous System Life
Corrective Maintenance	IFD - Development
	IFD - Maintenance
	Number Of Operational Users
	Latent TRs Discovered Per Op. User
	TR Constraint (Arrivals Per Month)
	% Ver Test Valid TR Discovery
	% Ver Test Invalid TR Discovery
	% CCB Invalid Discovery Rate
Perfective Maintenance	Average ECP Arrivals
	% ECP Backlog In Next Build
SLOC	Development SLOC
	Average New SLOC Per TR
	Average Deleted SLOC Per TR
	Average New SLOC Per ECP
	Average Deleted SLOC Per ECP
Cost	Person Hours Per TR
	Person Hours Per ECP
	Labor Rate

Table 1. Sectors and their associated input parameters.

Use Ctrl+shift+d for a shortcut to view a variable definition.

Each input consists of a variable name, a dropdown box for selecting historical data or custom inputs, a cell for entering custom data, and a units label. All parameters give the user the option of either selecting a parameter from a historical database or entering a custom input. By selecting the variable name or variable unit and clicking `Field Definition` in the top left of the sheet, you can view the definition of the parameter. For example, select the cell containing the variable name “Expected SW Life” in the Schedule sector. Click `Field Definition` and the Definition dialog will appear (Figure 3). Beneath the definition is the acceptable domain for a custom input. In this example, an input must be between 1 and 30, inclusive. These definitions and domains are also available in Appendix III.

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Variable Definition
EXPECTED SW LIFE
The expected life of the software is measured from the time that the software is first fielded following the initial development program to the time that the software is decommissioned or is no longer supported by a software maintenance organization.
Accepted values: 1 <= x <= 30
OK

Figure 3. The Field Definition dialog.

To select a parameter from the historical data set as an input for a particular parameter, click on the dropdown box next to the variable name and select a value (Figure 4).

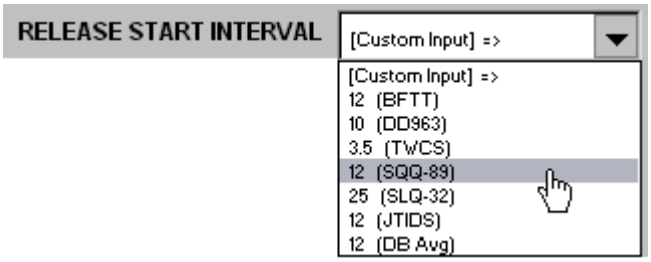

Figure 4. Selecting historical parameters as inputs.

If [Custom Input] is the only value available then no historical data exists for that variable. To quickly populate simulation parameters with values from one software system, select the system from the Historical System dropdown box in the upper right of the sheet. Selecting a program from this menu will populate the parameters with inputs from the selected program. Those parameters for which no input is available will be changed to [Custom Input] and will require a custom input from the user.

To enter a custom input for a variable, select [Custom Input] from the dropdown box (the first value in Figure 4). A blue-bordered box will appear to the right of the dropdown box (Figure 5). Type in the new value in this box and hit Enter.

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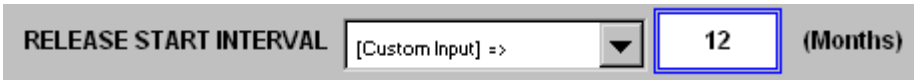

Figure 5. Selecting custom input as a variable input.

You may be presented with a validation error from SMPS if an illegal value is entered in the blue-bordered input box. An example is shown in Figure 6: SMPS is expecting a value greater than or equal to zero for Release Start Interval. Entering a value such as "s" will cause the Input Error dialog. Click `Retry` to retype the input; click `Cancel` to undo the change to the input.

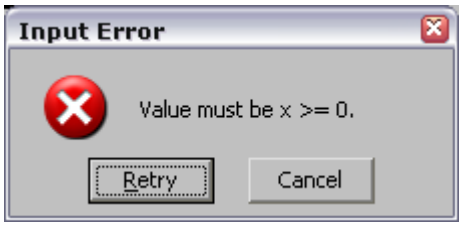

Figure 6. Input Error dialog from cell validation.

To prevent this error, use values only within the domain specified by the field definition for the variable. See the SMPS document *Framework of SMPS System Dynamics Tool* for a more detailed description of the input parameters for SMPS.

The final option available on the input sheet is the format of the cost output. Select the desired units from the `Output Cost Unit` dropdown box to format output from the simulation.

4) Run the simulation.

Use Ctrl+shift+r for a shortcut to run a simulation.

Once inputs have been entered for each parameter, click `Run` to execute the software maintenance process simulation. The Powersim application will appear in the taskbar as it runs the simulation file. Once the simulation has completed, SMPS will present you with the summarized information in the sheet `Output`.

5) View Summarized Output

Output data are available for viewing in both the SMPS Excel workbook and the Powersim simulation file.

SMPS Excel Workbook

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Raw Powersim output is in months. An element labeled as "per month" is an average of the 12 months that make up a year.

The sheet Output presents the simulation output by year in categories of related elements. The categories and elements are listed below in Table 2.

Category	Maintenance Hours	Maintenance Costs
Elements	Percent Time Elapsed Avg Corrective Hours per Month Avg Perfective Hours per Month Avg Total Maint Hours per Month Cum. Maintenance Hours Annual Maintenance Hours	Avg Corrective Cost per Month (FY03) Avg Perfective Cost per Month (FY03) Avg Total Maint Cost per Month (FY03) Cum. Maintenance Cost (FY03) Annual Maintenance Cost (FY03) Avg Corrective Cost per Month (TY) Avg Perfective Cost per Month (TY) Avg Total Maint Cost per Month (TY) Cum. Maintenance Cost (TY) Annual Maintenance Cost (TY)
Category	**Engineering Change Proposals**	**SLOC**
Elements	Avg ECP Backlog Avg ECPs Closed per Month Cum. ECP Arrivals Cum. ECP Closures Avg ECPs Entering by Release	Avg SLOC Avg SLOC Delta Avg New SLOC per Month Avg Deleted SLOC per Month
Category	**Trouble Reports**	
Elements	Cum. TR Arrivals Invalid TRs Avg Post CCB TR Arrival Rate Avg TRs Closed per Month Cum. TR Closures Avg TR Monthly Backlog Avg TRs Entering by Release	

Table 2. Categories and elements of the simulation output.

Maintenance Hours includes the average corrective, perfective, and total maintenance hours per month, as well as cumulative total hours. *Maintenance Costs* contains the costs associated with each Maintenance Hours element in both constant-year dollars and then-year dollars. Constant-year costs are in FY03 dollars and the first year of then-year dollars is always FY03. *Trouble Reports* includes average and cumulative trouble report arrival rates, monthly backlogs (the difference between cumulative arrivals at time *t* and cumulative closures at time *t*), and the average number of TRs entering releases. *Engineering Change Proposals* includes average and cumulative ECPs and the average number of ECPs entering releases. The last category, *SLOC*, includes average new, deleted, and the delta in SLOC counts per month, as well as a cumulative SLOC count over time. See the SMPS document *Framework of SMPS System Dynamics Tool* for a more detailed description of the simulation output of SMPS.

To change the output units of the costs, click the Inputs button and select the desired units from the Output Cost Unit dropdown box. You do not need to rerun the simulation to view different dollar units. Click the Output button in User Inputs to quickly return to the summarized output.

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SMPS Simulation File

To view line plot graphs of selected output elements in the Powersim simulation file, click on the Powersim application in the Windows Taskbar to open Powersim. The Powersim design document consists of diagram models, raw output data, and graphical output. Output is generated in the far right side of the Powersim Workspace window (Figure 7).

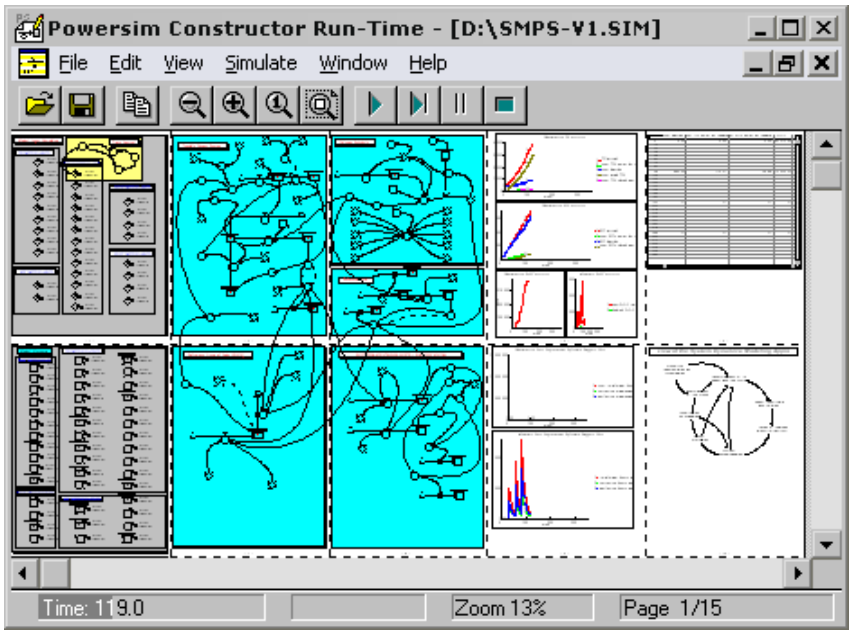

Figure 7. Viewing the Powersim run-time application output.

6) View Graphical Output

Graphs are available for viewing in both the SMPS Excel workbook and the Powersim simulation file.

SMPS Excel Workbook

To view line plot graphs of selected output elements, click `Graphs` while on the `Output` sheet. Graphs are grouped in the same categories as elements in the `Output` sheet: *Maintenance Hours*, *Maintenance Costs*, *Trouble Reports*, *Engineering Change Proposals*, and *SLOC*. To change the output units of the cost graphs, click the `Inputs` button and select the desired units from the `Output Cost Unit` dropdown box. You do not need to rerun the simulation to view different dollar units.

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SMPS Simulation File

To view line plot graphs of selected output elements in the Powersim simulation file, click on the Powersim application in the Windows Taskbar to open Powersim. Output is generated in the far right side of the Powersim Workspace window (see Figure 7).

Scrolling to the far right will allow you to view multiple-series line plots corresponding to the following categories of software maintenance: *Cumulative TR Activity*, including cumulative TR arrivals, closures, and backlogs; *Cumulative ECP Activity*, which shows cumulative ECP arrivals, closures, and backlogs; *Cumulative SLOC Activity* and *Monthly SLOC Activity*; *Cumulative Post Deployment Software Support Cost*; and *Monthly Post Deployment Software Support Cost*.

3 PROTECTING THE DATA

To prevent inadvertent changes to the data and algorithms that constitute SMPS, all worksheets, interface routines, and simulation routines are locked. Only those cells that offer options to the user or accept input from the user may be edited. In order to manipulate output data, you must copy the data in `Output` to a separate workbook.

It is possible to create a copy of the sheet Output within the SMPS workbook file. However, this is not recommended because of the potential confusion created by copying formulas with dynamic ranges. By copying the values of the sheet to another workbook you will be spared the burden misnamed ranges and increased file size!

SMPS opens the Powersim application to run the simulation file; after closing the SMPS Excel workbook you will also need to close Powersim. Powersim will ask you to save changes to the simulation file. You may choose `Yes` to save any output data that Powersim has stored in the simulation file. Saving the simulation file in this manner will not alter the simulation algorithms or routines.

Do not change the file name of the Excel workbook or alter the names of the original worksheets delivered with SMPS.

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Appendices

The following appendices are included as supplementary information to the User Manual:

Appendix I Selected Forms and Controls

Contains screenshots of the input and output interfaces of SMPS Version 1 with explanations of each available control.

Appendix II Common Errors

Lists several common errors from SMPS and Powersim. Below a screenshot of the error dialog are possible solutions to the error.

Appendix III Parameter Input Dictionary

Contains a table of ranges and definitions for each input necessary to execute a simulation.

Appendix IV SMPS Variable Names

Contains a table of variable names used for the simulation inputs across SMPS, user interface sheets, Excel formulae, and Visual Basic.

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Appendix I

Selected Forms and Controls

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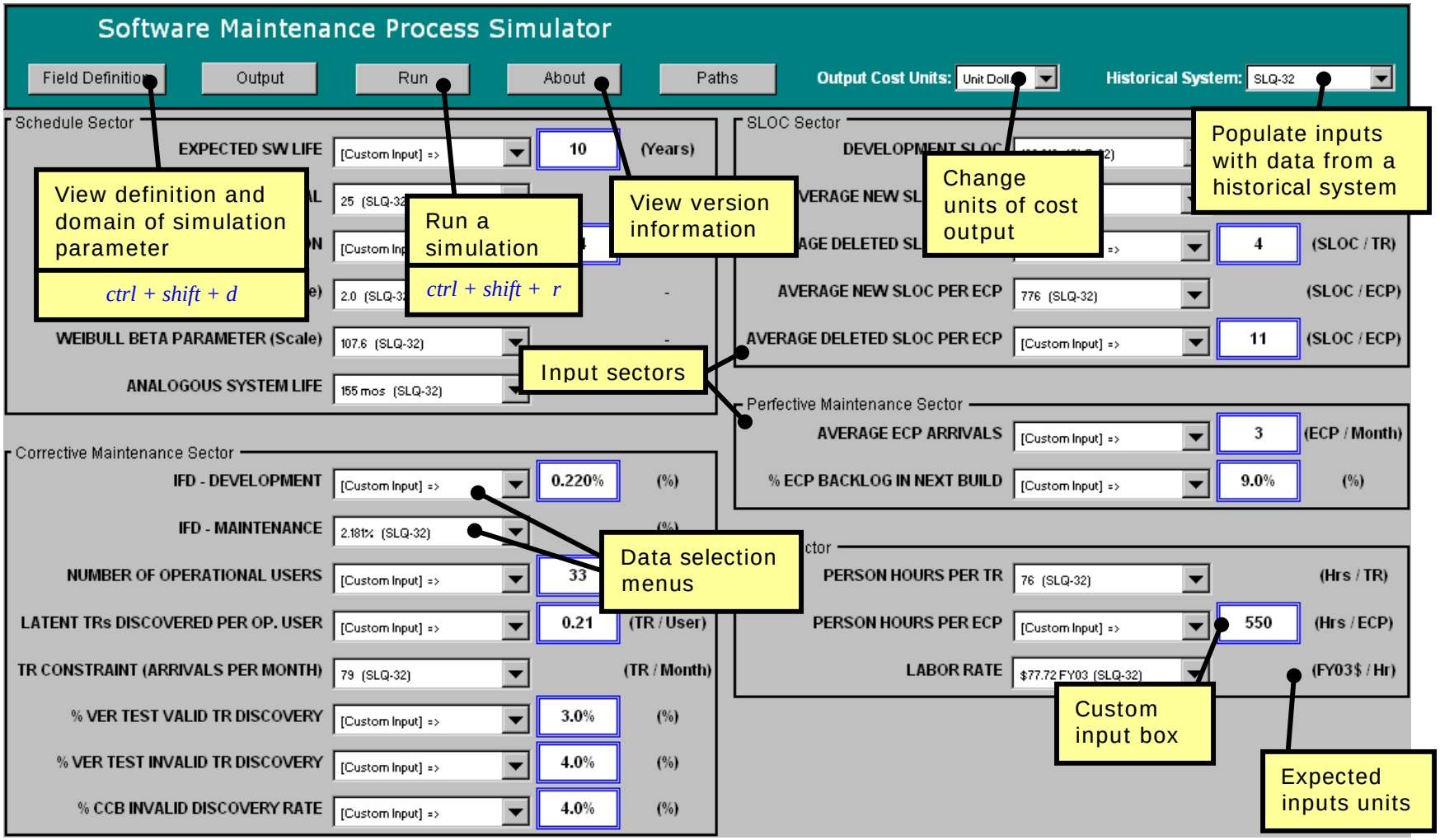

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Output Sheet

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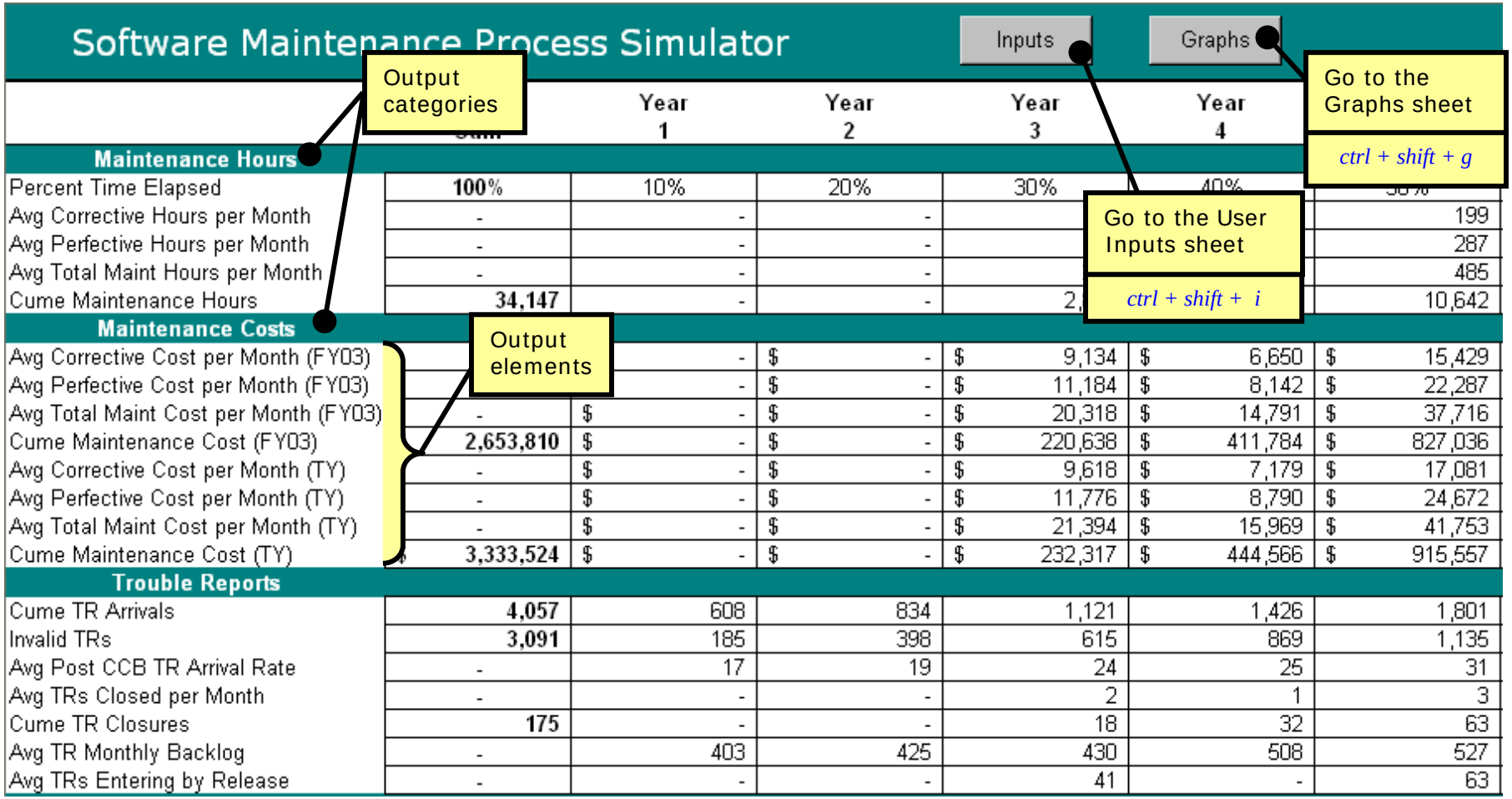

		Year 1	Year 2	Year 3	Year 4	
Maintenance Hours						
Percent Time Elapsed	**100%**	10%	20%	30%	40%	
Avg Corrective Hours per Month	-	-	-			199
Avg Perfective Hours per Month	-	-	-			287
Avg Total Maint Hours per Month	-	-	-			485
Cume Maintenance Hours	**34,147**	-	-	2,		10,642
Maintenance Costs						
Avg Corrective Cost per Month (FY03)		-	$ -	$ 9,134	$ 6,650	$ 15,429
Avg Perfective Cost per Month (FY03)		-	$ -	$ 11,184	$ 8,142	$ 22,287
Avg Total Maint Cost per Month (FY03)	-	$ -	$ -	$ 20,318	$ 14,791	$ 37,716
Cume Maintenance Cost (FY03)	**2,653,810**	$ -	$ -	$ 220,638	$ 411,784	$ 827,036
Avg Corrective Cost per Month (TY)	-	$ -	$ -	$ 9,618	$ 7,179	$ 17,081
Avg Perfective Cost per Month (TY)	-	$ -	$ -	$ 11,776	$ 8,790	$ 24,672
Avg Total Maint Cost per Month (TY)	-	$ -	$ -	$ 21,394	$ 15,969	$ 41,753
Cume Maintenance Cost (TY)	**3,333,524**	$ -	$ -	$ 232,317	$ 444,566	$ 915,557
Trouble Reports						
Cume TR Arrivals	**4,057**	608	834	1,121	1,426	1,801
Invalid TRs	**3,091**	185	398	615	869	1,135
Avg Post CCB TR Arrival Rate	-	17	19	24	25	31
Avg TRs Closed per Month	-	-	-	2	1	3
Cume TR Closures	**175**	-	-	18	32	63
Avg TR Monthly Backlog	-	403	425	430	508	527
Avg TRs Entering by Release	-	-	-	41	-	63

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Output Graphs Sheet

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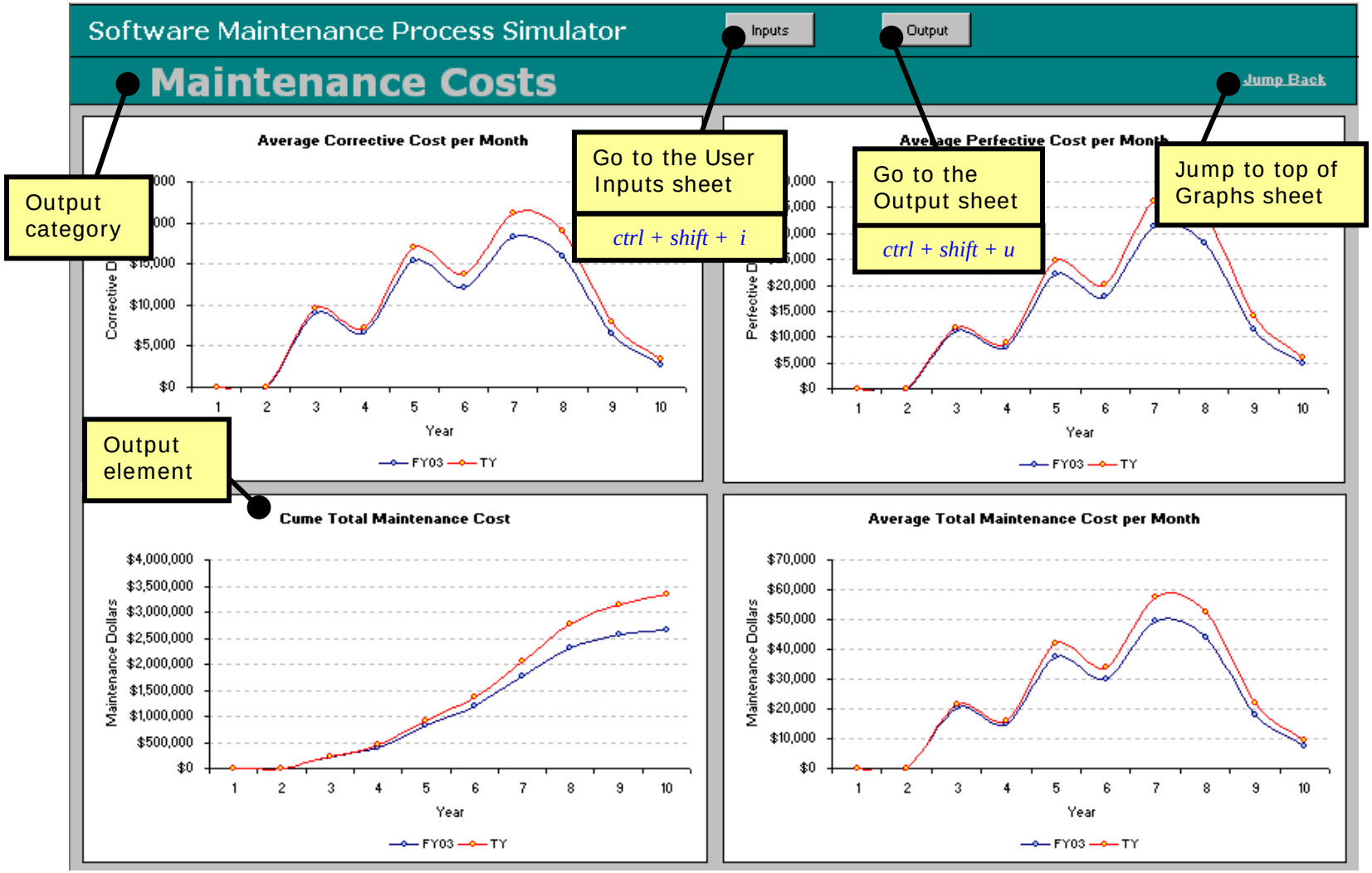

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Powersim® Application Diagrams & Output

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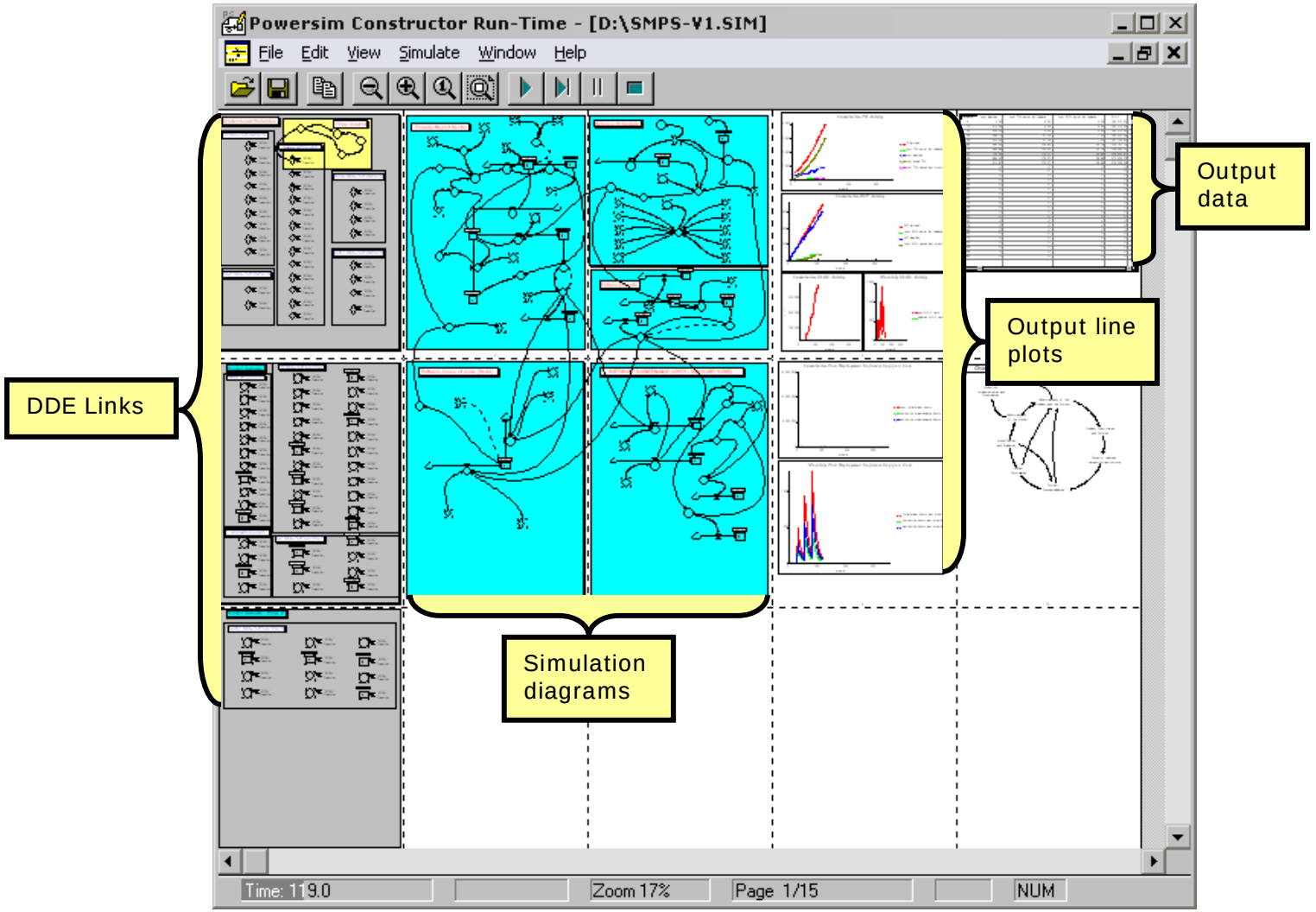

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Appendix II

Common Errors

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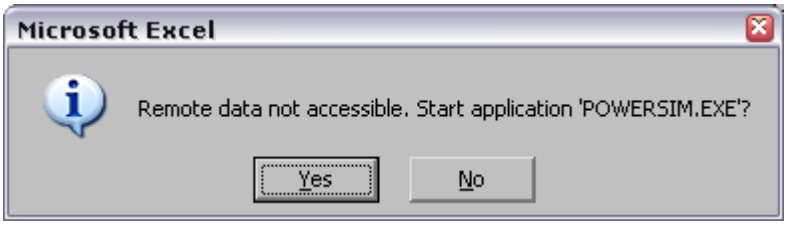
Listed below are several common errors from SMPS and Powersim. Beneath a screenshot of the error dialog are possible solutions to fix the error.

Cannot find "Powersim.exe."

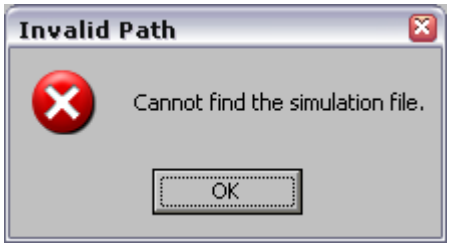
This is an error message from SMPS caused by an illegal path definition to the Powersim executable file. Click on Paths in the User Inputs sheet to edit the path to the Powersim executable file.

Remote data not accessible.



This is an error message from Excel caused by a failed DDE link. This is more than likely due to an invalid file path. Click on Paths in the User Inputs sheet to edit the path to the Powersim simulation file.

Cannot find the simulation file.



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This is an error message from SMPS caused by an illegal path definition to the simulation file. Click on Paths in the User Inputs sheet to edit the path to the Powersim executable file. If the path is correct, make sure that the path is entered as DOS format. No spaces are allowed for folder or file names, and any names longer than eight characters must be truncated by a tilde and a “1” character.

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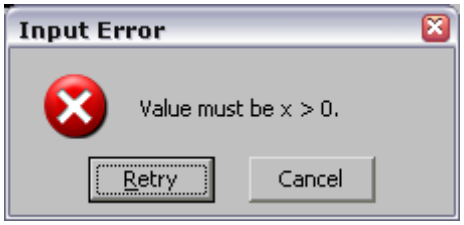
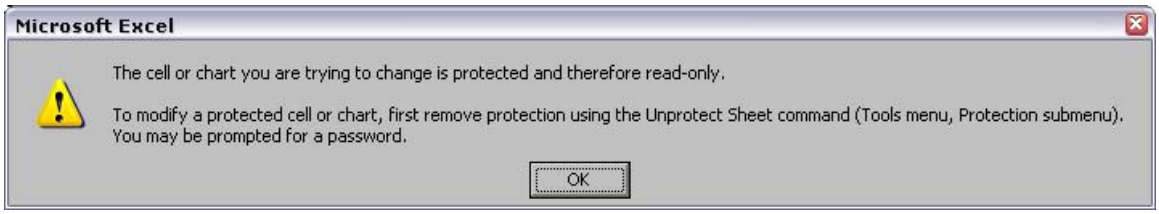
Input errors (various).



This error is caused by Excel validating user input for the custom inputs. Click Retry to retype the input; click Cancel to undo the change to the input.

The cell or chart you are trying to change is protected.


Microsoft Excel
The cell or chart you are trying to change is protected and therefore read-only.
To modify a protected cell or chart, first remove protection using the Unprotect Sheet command (Tools menu, Protection submenu). You may be prompted for a password.
OK

This error is raised by Excel to prevent changes to SMPS. All SMPS sheets are protected to prevent inadvertent changes to the data and algorithms. To modify or manipulate the output, copy the Output sheet to a different workbook.

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Appendix III

Input Parameter Dictionary

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Sector	Input Parameter	Units	Range	Definition
Schedule	Expected SW Life	Years	1 <= x <= 30	The expected life of the software is measured from the time that the software is first fielded following the initial development program to the time that the software is decommissioned or is no longer supported by a software maintenance organization.
	Release Start Interval	Months	x >= 0	Months between the start of work on new releases. Start of work usually corresponds to the beginning of software/system design, or the date of 'requirements close-out.'
	Release Work Duration	Months	x > 0	Months required to finish work on a release once the work has started. This duration of time includes the effort required from requirements close-out to release implementation.
	Weibull Alpha Parameter (Shape)	*(None)*	x > 0	This parameter, along with the Weibull beta parameter, defines the shape of the distribution to be applied to the TR closures. The distribution defines the rate at which TRs are accepted into the various software builds over the life of the program. The effect of the shape parameter is to vary the shape of the distribution to include exponential, right-skewed, or symmetric distributions. Distributions used here are normally of the right-skewed variety.
	Weibull Beta Parameter (Scale)	*(None)*	x > 0	This parameter, along with the Weibull alpha parameter, defines the shape of the distribution to be applied to the TR closures. The distribution defines the rate at which TRs are accepted into the various software builds over the life of the program. The effect of the scale parameter is to stretch out the distribution for larger scale parameters.
	Analogous System Life	Any	10 <= x <= 11,000	This input can be measured in any units, as long as it is consistent with the units that were used to estimate the corresponding Weibull parameters.

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Sector	Input Parameter	Units	Range	Definition
Corrective Maintenance	IFD - Development	%	0 <= x <= 1	Inherent Fault Density; measured in terms of number of faults per line of code. These are the known faults already in the backlog at the time of software delivery following the initial development phase. IFD Development is a function of the skill level of the software developers.
	IFD - Maintenance	%	0 <= x <= 1	IFD = Inherent Fault Density; measured in terms of number of faults per line of code. These are the known faults discovered through unit test and system integration testing of follow-on maintenance releases. IFD Maintenance is a function of the skill level of the software maintainers.
	Number Of Operational Users	Unit	x >= 0	Number of users of the software. Number of installation sites can be substituted here as long as 'Latent TRs Discovered per Operational User' is modified to reflect sites also.
	Latent TRs Discovered Per Op. User	TRs / User	x >= 0	Rate of latent defects discovered per operational user. This reflects the discovery of 'unknown' defects associated with the software by the user community. Software installation sites can be substituted for users as long as the 'Number of Operational Users' is modified to reflect sites also.
	TR Constraint (Arrivals Per Month)	TRs / Month	x >= 0	This value constrains the simulation to a maximum allowable number of TR arrivals per month. The simulator will compare this value to the calculated value and accept the lower of the two values. Setting this input to a very high value will result in an unconstrained simulation.
	% Ver Test Valid TR Discovery	%	0 <= x <= 1	As TRs undergo verification testing, some additional new TRs may be discovered. This factor represents the additional percent of backlog corresponding to new valid TRs discovered as a result of verification testing.
	% Ver Test Invalid TR Discovery	%	0 <= x <= 1	Percent of TR backlog found to be invalid as a result of verification testing.
	% CCB Invalid Discovery Rate	%	0 <= x <= 1	Percent of total TR arrivals that are found to be invalid by the change control board.

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Sector	Input Parameter	Units	Range	Definition
Perfective Maintenance	Average ECP Arrivals	ECPs / Month	x >= 0	This is the average number of ECP or enhancement requests logged in per month through the life of the program. All ECP or enhancement requests that are logged in are automatically found to be 'valid.'
	% ECP Backlog In Next Build	%	0 <= x <= 1	This factor represents the percentage of the current ECP or enhancement backlog that will be implemented in the next software build or release. The percentage remains constant through the life of the program.
SLOC	Development SLOC	SLOC	x > 0	Number of lines of code delivered to the customer following the software development phase.
	Average New SLOC Per TR	SLOC / TR	x >= 0	Average new SLOC added per TR.
	Average Deleted SLOC Per TR	SLOC / TR	x >= 0	Average SLOC deleted per TR.
	Average New SLOC Per ECP	SlOC / ECP	x >= 0	Average new SLOC added per ECP.
	Average Deleted SLOC Per ECP	SlOC / ECP	x >= 0	Average SLOC deleted per ECP.
Cost	Person Hours Per TR	Hours / TR	x > 0	This value represents the average number of person hours required to close a TR. Effort for design, code and test of fixes are included.
	Person Hours Per ECP	Hours / ECP	x > 0	This value represents the average number of person hours required to implement an ECP. Effort for design, code and test of the enhancement are included.
	Labor Rate	FY03$ / Hour	x > 0	This is the labor rate to be applied to the person hours. The rates provided in the historical data sets are 'unburdened,' meaning they do not include costs for overhead or fee. They are also 'composite' meaning they represent weighted averages over all labor categories.

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Appendix IV

SMPS Variable Names

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Model Sector	*User Input Variable Name*	*Interface Sheet Name*	*Database Reference Name*	*Powersim Name*
Schedule	EXPECTED SW LIFE	Expected Sw Life In Years	Life	sw_life_years
Schedule	RELEASE START INTERVAL	Release Start Interval	Rstart	release_start_interval
Schedule	RELEASE WORK DURATION	Release Work Duration	Rwork	release_work_duration
Schedule	WEIBULL ALPHA PARAMETER (Shape)	Weibull Alpha Parameter ==> (Shape)	Alpha	
Schedule	WEIBULL BETA PARAMETER (Scale)	Weibull Beta Parameter ==> (Scale)	Beta	
Schedule	ANALOGOUS SYSTEM LIFE	Analogous System Life (Years)	aLife	
Corrective Maintenance	IFD - DEVELOPMENT	IFD - Development	ifd_d	development_inherent_fault_density
Corrective Maintenance	IFD - MAINTENANCE	IFD - Maintenance	ifd_m	maintenance_inherent_fault_density
Corrective Maintenance	NUMBER OF OPERATIONAL USERS	Number Of Operational Users	OpUsers	number_of_operational_users
Corrective Maintenance	LATENT TRs DISCOVERED PER OP. USER	Latent TRs Discovered Per Oper. User	Latents	latent_TRs_discovered_per_op_user
Corrective Maintenance	TR CONSTRAINT (ARRIVALS PER MONTH)	TR Consaint TR (TR Arrivals Per Month)	TRConstraint	TR_constraint
Corrective Maintenance	% VER TEST VALID TR DISCOVERY	% Ver Test Valid TR Discovery	VerTestValid	percent_ver_test_valid_discovery_rate
Corrective Maintenance	% VER TEST INVALID TR DISCOVERY	% Ver Test Invalid TR Discovery	VerTestInvalid	percent_ver_test_invalid_discovery_rate
Corrective Maintenance	% CCB INVALID DISCOVERY RATE	% CCB Invalid Discovery Rate	CCBInvalid	percent_CCB_invalid_discovery_rate
SLOC	DEVELOPMENT SLOC	Development Sloc	DSLOC	development_SLOC
SLOC	AVERAGE NEW SLOC PER TR	Average New Sloc Per TR	NewSLOCtr	ave_new_SLOC_per_TR
SLOC	AVERAGE DELETED SLOC PER TR	Average Deleted Sloc Per TR	DelSLOCtr	ave_deleted_SLOC_per_TR
SLOC	AVERAGE NEW SLOC PER ECP	Average New Sloc Per ECP	NewSLOCecp	ave_new_SLOC_per_ECP
SLOC	AVERAGE DELETED SLOC PER ECP	Average Deleted Sloc Per ECP	DelSLOCecp	ave_deleted_SLOC_per_ECP
Perfective Maintenance	AVERAGE ECP ARRIVALS	Average ECP Arrivals Per Month	ECPmonth	rate_ECP_arrivals
Perfective Maintenance	% ECP BACKLOG IN NEXT BUILD	% ECP Backlog In Next Build	ecpBacklog	percent_of_ECP_backlog_in_next_build
Cost	PERSON HOURS PER TR	Person Hours per TR	HrsTR	average_person_hours_per_TR
Cost	PERSON HOURS PER ECP	Person Hours per ECP	HrsECP	average_person_hours_per_ECP
Cost	LABOR RATE	Unburdened Hourly Labor Rate	Rate	labor_rate
Schedule		Period 1 Build Percentage		per1_build_percentage
Schedule		Period 2 Build Percentage		per2_build_percentage
Schedule		Period 3 Build Percentage		per3_build_percentage
Schedule		Period 4 Build Percentage		per4_build_percentage
Schedule		Period 5 Build Percentage		per5_build_percentage
Schedule		Period 6 Build Percentage		per6_build_percentage
Schedule		Period 7 Build Percentage		per7_build_percentage
Schedule		Period 8 Build Percentage		per8_build_percentage
Schedule		Period 9 Build Percentage		per9_build_percentage
Schedule		Period 10 Build Percentage		per10_build_percentage